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Snowflake BDT

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Another technology. Why?

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- Technologies just evolve and change … nowadays maybe even faster
- 2000s – RDBMS, vertical scaling
  - Relational data, DWH
- 2010s – clusters, horizontal scaling
  - Data lake concept, unstructured and semistructured data
  - BDT begins – on-premise Hadoop cluster, MapReduce / Spark
  - Open Source … but still may lead to vendor lock-in (Cloudera)
- 2020s – widespread cloud adoption
  - Lakehouse, unified data platforms …
  - Data for AI
- 2030s - ???

What is Snowflake

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snowflake

THE SNOWFLAKE PLATFORM

“A single, fully managed platform that powers the AI Data Cloud. Snowflake securely connects businesses globally across any type or scale of data to productize AI, applications and more in the enterprise.”

https://www.snowflake.com/en/data-cloud/platform/

Brief History

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- Founded in 2012 by former Oracle engineers – Benoit Dageville, Thierry Cruanes
- Relational DB in cloud – initially focused on DWH
  - Resource elasticity (data, compute)
  - Fault isolation
  - Performance isolation
- Currently
  - 10,000+ customers
  - 5 billion queries processed daily
  - 2,500 Marketplace listings

Core concepts

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- Cloud agnostic
  - AWS, Azure, GCP
  - Interoperability
    - Between SNFL *accounts*
    - Between SNFL account and various cloud providers
- Cloud oriented
  - Data ingestion – primary sources are data stored in cloud services (Azure Blob Storage, AWS S3, Google Cloud Storage)
  - Cloud only, infrastructure provisioned by Snowflake
    - You cannot deploy Snowflake on your local device
    - Neither BYOC

Account

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- Organization – company or similar
  - Accounts – linked with organization
- Account
  - Snowflake account ~ DB instance/machine
  - Cloud provider, region – cannot change later
  - Edition (Standard, Enterprise, Business Critical, *Virtual Private Snowflake*)
- Want to try it out?
  - https://signup.snowflake.com/
  - 30 days for free, 400 USD credit
  - Select at least Enterprise edition to unlock most features
  - *So far no restrictions on number of trial accounts – you may create more than one at time or register a new one when the trial period expires*

Snowflake - Architecture

Architecture

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- Self-managed Data Platform
  - Snowflake handles all infrastructure (HW, SW, maintenance)
- Data storage and compute resources separation
  - Compute Layer (Virtual Warehouse, Serverless)
  - Data Storage
  - Cloud Services
- Hybrid of *shared-disk* and *shared-nothing* architectures
  - Shared-disk – data stored at a central data repository accessible from all compute nodes
  - Shared-nothing – MPP – each node in the cluster stores a portion of data set locally during computation

Architecture

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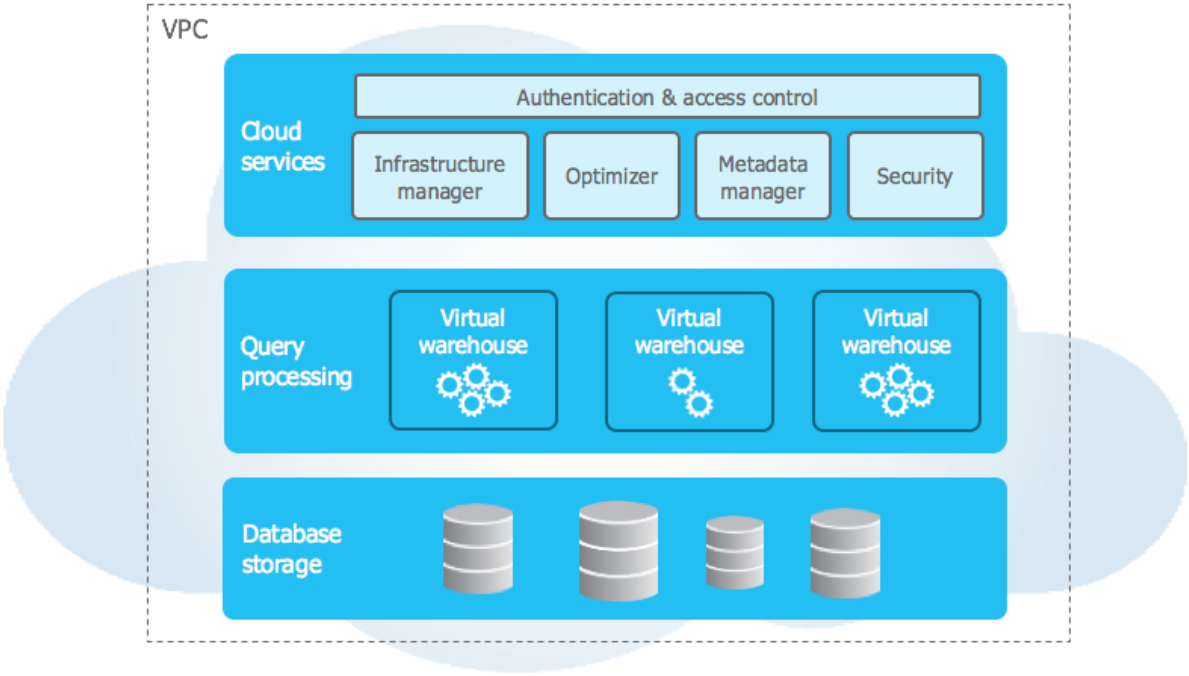

Ref: https://docs.snowflake.com/en/user-guide/intro-key-concepts

Compute layer

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- Virtual Warehouse (WH)
  - Main computing resource
  - Active WH is necessary for most operations
- May create multiple WH per account
  - Separate monitoring, access controls, sizing, tagging …
- Sizing
  - Currently 10 sizes from X-Small (XS) to 6X-Large

    + *Snowpark Optimized* counterparts for M-6XL sizes – ML/AI tasks
  - Exact technical specifications are not public
- Scaling – both up/down and in/out (even online)
  - Scaling-out – only in Enterprise and higher editions, 1-10 *clusters*

Compute layer II

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- Serverless – cannot create directly, only for *tasks/pipes* (see later)
- What if I need GPUs?
  - Last year's addition to Snowflake
  - Snowpark Container Services
  - Analogy to Docker / Kubernetes / OCP
    - Image run on a compute pool instances
- **Cost attribution**
  - I know who ran what workload and how many credits it consumed
  - Great leap from RDBMS

So what is in Snowflake?

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What is Snowflake made of?

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- Database objects
  - Everything is a database object
  - Database, Schema, Table, Views, …
  - Users, Roles, Tasks, Integrations, Notebooks, …
- SQL command for everything
  - Connection to git? Set up API integration

```
CREATE OR REPLACE API INTEGRATION my_git_api_integration
                    API_PROVIDER = git_https_api
                    API_ALLOWED_PREFIXES = ('https://github.com/my-account')
                    ALLOWED_AUTHENTICATION_SECRETS = (my_git_secret)
                    ENABLED = TRUE;
```

Objects Hierarchy

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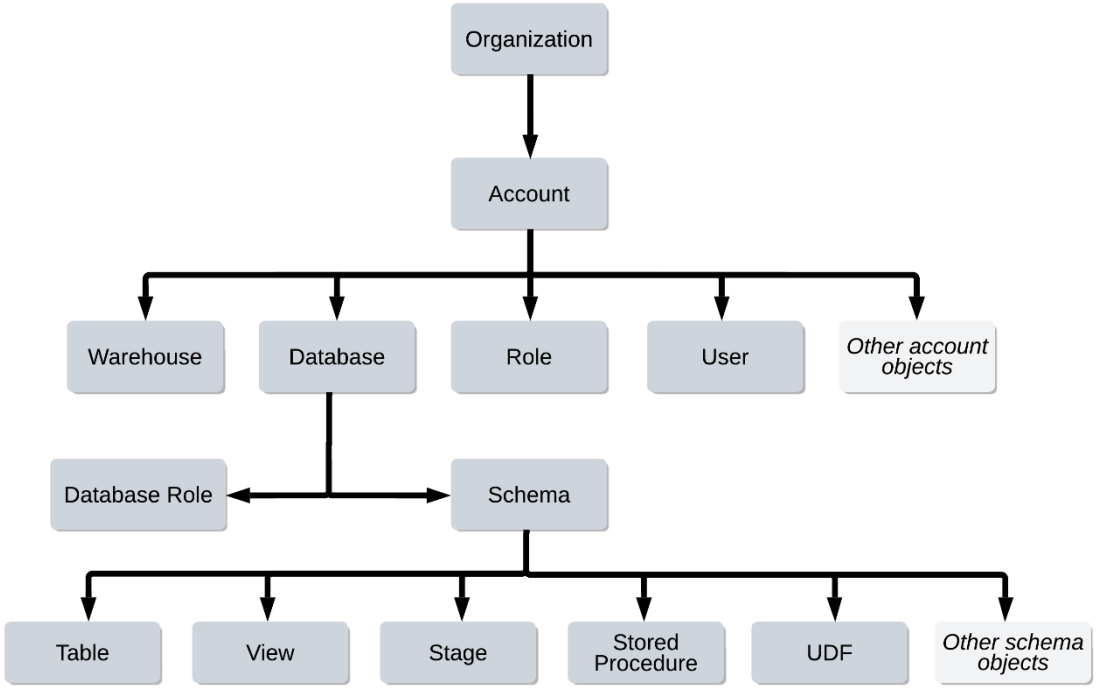

Ref: https://docs.snowflake.com/en/user-guide/security-access-control-overview

Database Objects

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- Structure fairly similar to common relational DBs
  - Database – schema – tables/views/functions…
- Differences
  - *Role* (user/account-level) vs *Database Role*
    - RBAC – Snowflake cares about **roles**, not about users
  - Stage – landing point for data (un)loading
    - Internal – primarily for ad-hoc data uploaded from local machines
    - **External** – connection to cloud data storage accounts
      - AWS S3, Azure Blob Storage, Google Cloud Storage
  - Other special types
    - Integrations, Masking Policies, Data Quality Measures, …

Storing the data

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- Many table types serving different purposes/use-cases
  - Internal Table
    - Transient, Temporary
  - External Table
  - Directory Table
  - Dynamic Table
  - Event Table
  - Hybrid Table
- Main difference to standard relational DBs:
  - PKs, FKs unenforced
  - No indexes, no (explicit) partitioning

Data Storage

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- Using data storage services of underlying cloud providers
  - VPS – storage account dedicated only for the account
  - Others – all accounts in one region share one centralized storage account
- Data Format (for **internal** tables)
  - Column-oriented
  - Proprietary and private
- Micro-partitioning
  - Automatically for all Snowflake internal tables
  - Compressed data file (disk segment), typically 50-500 MB (*pre-compression*)
  - Metadata about value ranges, selectivity etc. -> efficient filtering and pruning
  - Snowflake claims it is efficient for tables up to 5 TB large

Micro-partitions

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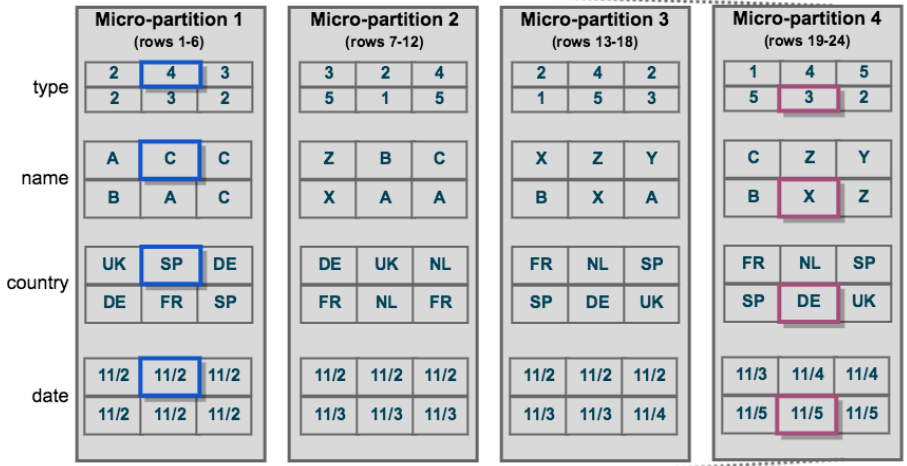
Table: `t1`

Logical Structure

type	name	country	date
2	A	UK	11/2
4	C	SP	11/2
3	C	DE	11/2
2	B	DE	11/2
3	A	FR	11/2
2	C	SP	11/2
3	Z	DE	11/2
2	B	UK	11/2
4	C	NL	11/2
5	X	FR	11/3
1	A	NL	11/3
5	A	FR	11/3
2	X	FR	11/2
4	Z	NL	11/2
2	Y	SP	11/2
1	B	SP	11/3
5	X	DE	11/3
3	A	UK	11/4
1	C	FR	11/3
4	Z	NL	11/4
5	Y	SP	11/4
5	B	SP	11/5
3	X	DE	11/5
2	Z	UK	11/5

Physical Structure



Ref: https://docs.snowflake.com/en/user-guide/tables-clustering-micropartitions

Clustering depth

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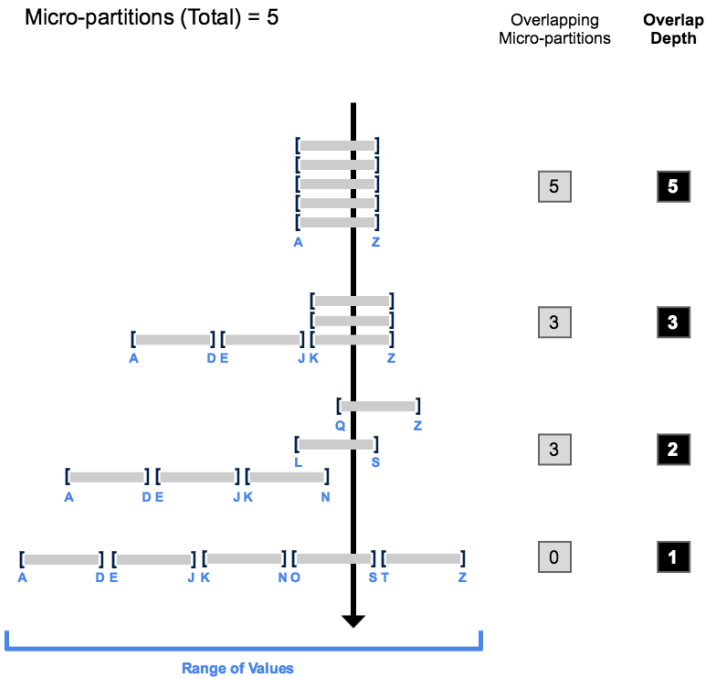
- Measure for efficient query pruning
- May be different for each column
- Lower depth ~ faster queries
- Affected by load patterns
  - Random vs bulk load



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Clustering, Other data formats

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- Micro-partitioning is used in internal tables
- When micro-partitioning is not performing well, you may declare **clustering keys**
- Support for unstructured and semi-structured data
  - Semi-structured
    - JSON, XML, Avro, Parquet, ORC – directly supported by native functions
    - VARIANT column
  - Unstructured
    - BLOB/CLOB – very limited size in internal tables (16 MB)

Table Features

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- Time travel
  - pros: error rollback, quasi-historization
  - cons: cost

```
SELECT * FROM my_table AT(TIMESTAMP => 'Wed, 26 Jun 2024 09:20:00 -0700'::timestamp_tz);

SELECT * FROM my_table AT(OFFSET => -60*5);
```

- Fail-safe period
  - 7-days, not for transient and temporary tables
  - “Best-effort” if some critical damage happens to your data
    - Exterme operational failures
    - Security breach

Tables, views

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- All table types can be queried together
  - We can join internal, external, directory and hybrid table together in one query
  - We can declare views over any table type
- Views
  - Secure Views
    - Suppressing some internal optimizations so the consumer cannot indirectly see or deduce data they aren’t privileged to (e.g. through query plan or aggregation queries)
    - Only view owners can see its definition
  - Materialized Views
    - For large or complex queries, results refreshed automatically
    - Only in Enterprise and higher editions; can be also Secure Materialized Views

Data Loading and Transformations

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- Relevant objects
  - Orchestration and scheduling
    - Tasks
    - Streams
    - Pipes
  - Incoming data storage
    - Stage (internal or external)
  - Table types
    - Dynamic tables
    - External tables
    - Directory tables
    - (and of course – “standard” internal tables)

Batch loading

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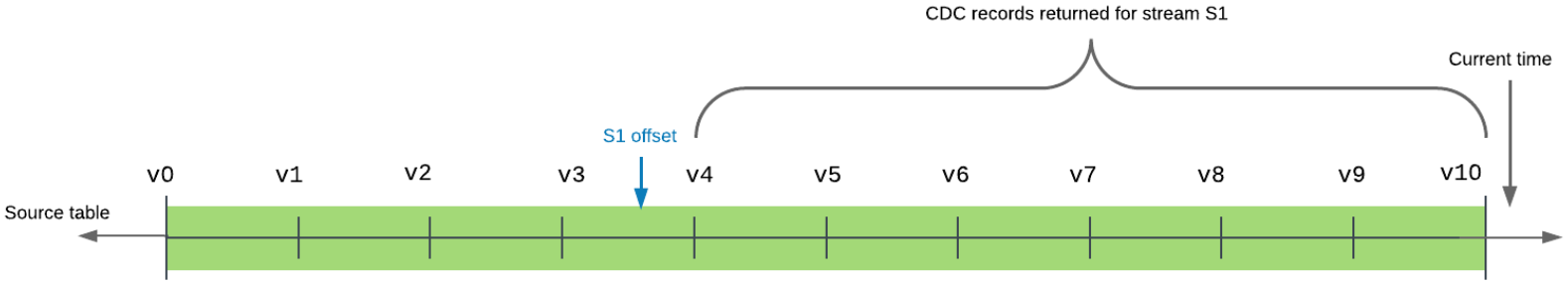
- Tasks + streams
- Stream – Change Data Capture (CDC)



- Consumed only once -> multiple consumers need multiple streams

Batch loading

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- Task
  - Scheduled (e.g. every 10 minutes)
  - Triggered - by stream or by another task
  - Serverless or running on user managed WH

```
CREATE TASK my_triggered_task
                    TARGET_COMPLETION_INTERVAL='15 MINUTES'
                    WHEN SYSTEM$STREAM_HAS_DATA('my_order_stream')
                    AS
                                        INSERT INTO customer_activity
                                        SELECT customer_id, order_total, order_date, 'order'
                                        FROM my_order_stream;
```

Continuous loading

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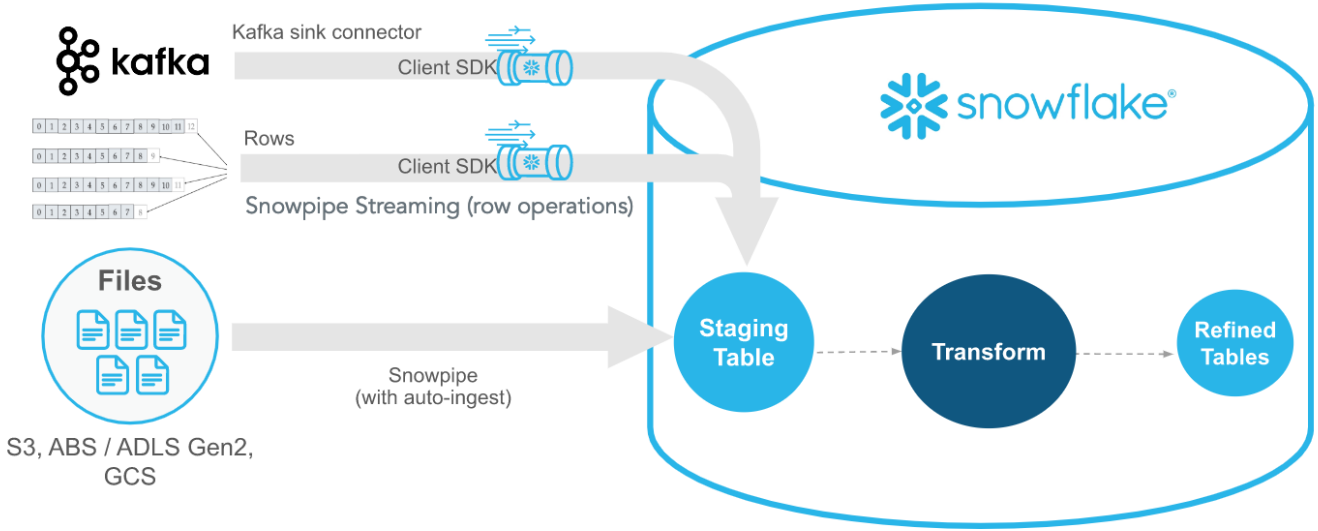
- Snowpipe
  - Monitor external stage and trigger pipeline when new data arrives
  - Map external storage to ext. stage (Amazon S3, Azure Blob Storage)
  - Consume events about new data from PubSub services
    - Azure EventGrid, Amazon SNS/SQS
- Snowpipe Streaming
  - connecting directly to external stream (Kafka)



[Snowpipe Streaming | Snowflake Documentation]

Dynamic tables

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- Declarative transformation framework (cf. Delta Live Tables in DBX)
  - Similar results could be achieved with other previously mentioned methods, but with much more code
- Configurable “data freshness” / target lag

```
CREATE OR REPLACE DYNAMIC TABLE names
TARGET_LAG = '1 minute'
WAREHOUSE = mywh
AS
SELECT
                    var:id::int id,
                    var:fname::string first_name,
                    var:lname::string last_name
FROM raw;
```

Hybrid tables

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- Getting back to RDBMS times
  - ACID, referential integrity
  - PKs, FKs enforced, good old indexes
- For real-time transactional use-cases
  - Random read/writes
  - Unistore concept

Functions, Procedures, Scripting

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- Snowflake provides rich set of predefined functions
  - Window functions
  - Analytic functions (time-series, MATCH)
  - Approximate functions (similarity, percentiles …)
- User defined functions and procedures
  - Supports multiple languages
    - SQL, Python, Java, JavaScript
- External functions (executed outside Snowflake)
- Scripting – REST API, Python API
- **Snowpark** – for data processing, similar to Apache Spark (based on DataFrame paradigm)

Data sharing

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- Zero-copy cloning
- Data replication
  - Same organization, to accounts in different regions
- **Data sharing**
  - One of the strongest Snowflake features
  - Share data with accounts from other organizations (in the same region)
  - If replicated, may share data even across different regions and cloud providers
  - Consumer – read-only, but no additional costs (data stored only at provider)
  - Multiple methods
    - Marketplace listings, Secure Data Sharing, Data Exchange, Clean Rooms

Features Overview

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- Masking policies (row-level, column-level)
- Snowflake/Snowpark ML
  - Set of services for ML and MLOps, mimicking Mlflow
  - Model Registry, Feature Store, Datasets
- Applications
  - Streamlit, Snowflake Native App
- Snowpark Container Services
  - For Native Apps or Snowpark ML model serving

Snowflake ML/AI

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- Rapidly evolving in last years/months
- 2024 – introducing interactive notebooks
- LLM – **Snowflake Cortex**
  - Multiple models supported (mistral, llama, Snowflake Arctic …)
  - RAG – native support for vector embeddings storage (VECTOR datatype)
  - Cortex Search – out-of-box RAG over stored documents
  - Cortex Analyst – answering nature language questions about data
  - Document AI – extraction and classification of documents

Resources - Billing

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- So what does Snowflake charge you for?
  - Data storage (20-40 USD/TB per month)
  - Compute costs – in term of *credits*
  - 1 Snowflake credit ~ 2-10 USD (varies by provider, region and edition)
    - Virtual warehouses – 1 credit = 1 hour of XS warehouse uptime
    - Serverless – actual compute time
    - Cloud services – usually negligible
  - Data transfer costs
    - *Egress* (outbound traffic) from Snowflake account – both unloading to data storage (e.g. AWS S3) or Snowflake accounts in another regions
    - *Ingress* generally not charged (by Snowflake, cloud providers *will* charge some fee…)

Resources - Control

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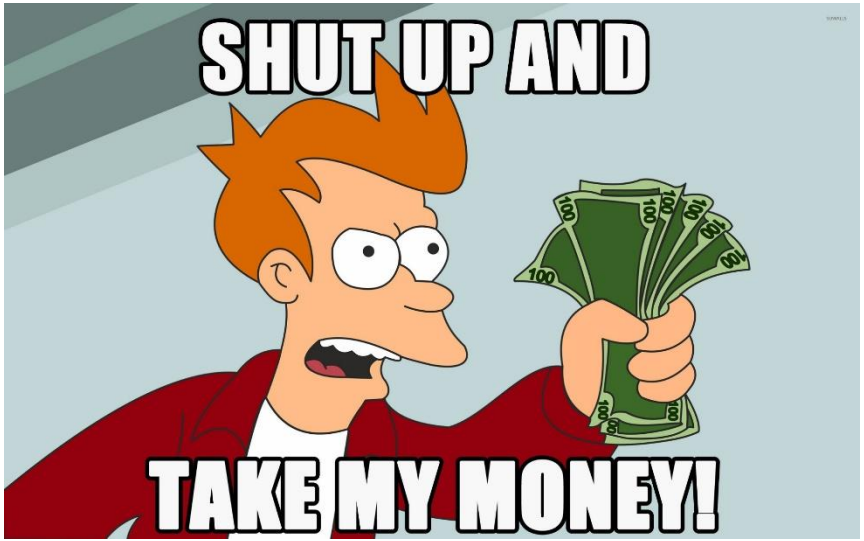
- Almost unlimited resources
- If you pay for it



Resources - Monitoring

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- How to control our bills?
- Resource Monitor
  - Formally just another DB object type
  - Controls credit consumption of *virtual warehouses*
  - Actions – Notify, Suspend, Suspend immediately
  - But it doesn’t monitor serverless features or cloud services usage
- Internal metadata tables
- Cost attribution
  - Using ACCOUNT_USAGE tables and tags
  - Per organizational unit, user or query

Polaris, Horizon

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Snowflake Horizon Catalog

- Counterpart to Unity Catalog, Snowflake governance solution
- Governing data, apps and models across whole organization in single place
- Focused on Snowflake, but may integrate (on some level) data from external sources, mainly if they use Apache Iceberg format

Polaris Catalog

- Open source (one of first Snowflake open-sourced projects)
- Using Apache Iceberg REST API for integrations
- Deployment: not necessarily on Snowflake
- Ambition: cross-engine universal catalog, industry standard
  - Integrations with Databricks, Fabric?

Almost finishing … some of Snowflake Tops

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- Modern approach to old relational databases
  - Easy function/procedures definition in Python, JavaScript and Java
  - GitOps, dbt
  - Non-standard SQL features
    - CREATE OR ALTER
    - GROUP BY ALL, UNION BY NAME
    - Trailing comma
    - Calculated column reference by name in the same SELECT
    - And many others …
  - Constant improvement
    - Materialized views pricing
    - Non-critical tasks scheduling

Snowflake Ecosystem

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Questions

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Thank you

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